

The Great Austral Nearby Young Association ¹

C. A. O. Torres, G.R. Quast

Laboratório Nacional de Astrofísica/MCT, 37504-364 Itajubá, Brazil

R. de la Reza, L. da Silva

Observatório Nacional/MCT, 20921-030 Rio de Janeiro, Brazil

C. H. F. Melo

Geneva Observatory, CH-1290 Sauverny, Switzerland

Abstract. Observing ROSAT sources in an area covering $\sim 30\%$ of the Southern Hemisphere, we found evidences for a great nearby association (GAYA), comprising the proposed associations of Horologium (HorA) and the eastern part of Tucana (TucA), formed by at least 44 Post-T Tauri stars. The stars of the GAYA have similar space velocity components relative to the Sun $(U, V, W) = (-9.8 \pm 1.2, -21.7 \pm 1.1, -2.0 \pm 2.2)$ km/s and their Li line intensities are between those of the classical T Tauri stars and the ones of the Local Association stars. The distances of the members of the GAYA cover an interval of ~ 70 pc, compatible with the angular size of $\sim 60^\circ$ and in agreement with an initial velocity dispersion of ~ 1.5 km/s and its evolutive age. We found many other young stars, not members of the GAYA. We also observed a control region near the equator, covering 700 square degrees, where we found only four young stars. The overabundance of young stars near the South Pole (by a factor of five) seems to show that there may be other young associations not yet characterized.

1. Introduction

Surveys of young pre-main-sequence (PMS) stars based on IRAS colors detect mainly the classical T Tauri stars (CTT), due to their important dusty accretion disks. One of the most comprehensive surveys was the “Pico dos Dias Survey” (PDS) (Gregorio-Hetem et al. 1992; Torres et al. 1995; Torres 1998). As the disks around the Post-T Tauri stars (PTT) should have been dissipated or agglutinated into planetesimals, they hardly would be detected in this way. They could belong to physically dispersed groups, with ages larger than the

¹Based on observations made under the Observatório Nacional-ESO agreement for the joint operation of the 1.52 m ESO telescope and at the Observatório do Pico dos Dias, operated by MCT/Laboratório Nacional de Astrofísica, Brazil

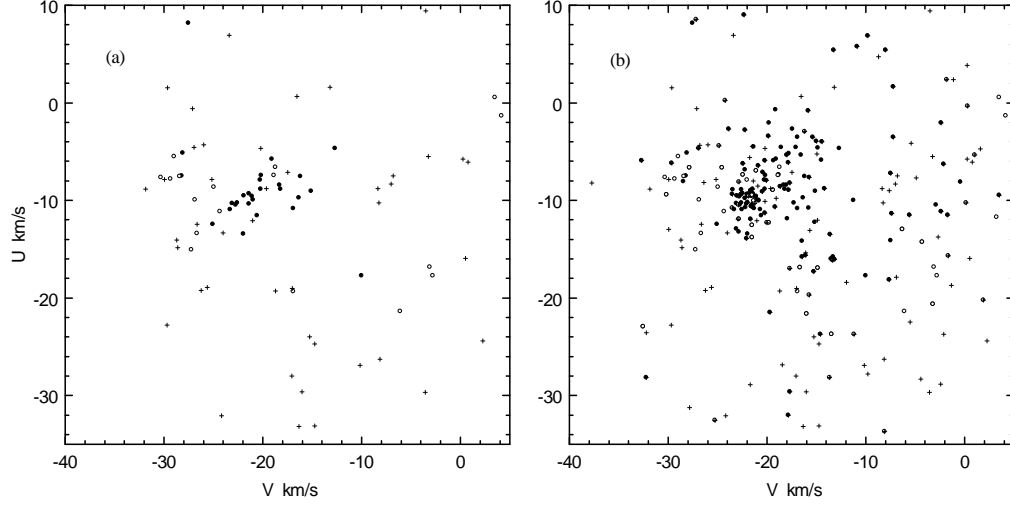


Figure 1. UV space velocities for the stars observed in the SACY.

(a) Hipparcos stars.

(b) All stars, including those with kinematical parallaxes.

Filled circles, open circles and plus represent the stars with Li I lines stronger, similar or weaker (or absent) than the Pleiades, respectively. The concentration near $(-10, -20)$, in both figures, is the GAYA. There are stars out of the figure boundaries.

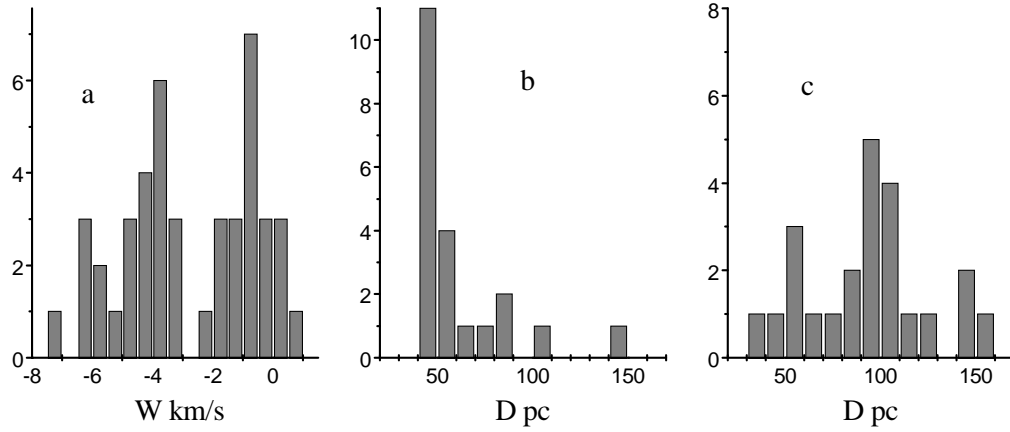


Figure 2. (a) is the histogram of the W velocities for the proposed members of the GAYA. There seems to be a bimodal distribution that reflects in the distribution of the distances: (b) for the right peak and (c) for the left one. It is not yet clear if these distributions represent a real split in the GAYA or some bias in the sample or introduced in some way by our statistical approach.

mean lifetime of the original clouds, and, in such case, they may be located far from any cloud. We discovered the first of this kind of association when we were searching for new T Tauri stars (TTS) around TW Hya (de la Reza et al. 1989; Gregorio-Hetem et al. 1992). The detection of X-ray sources by the ROSAT All-Sky Survey (RASS) associated with TTS outside star formation regions (Neuhäuser 1997) gave a new tool to find other associations of this kind. In fact, Torres et al. (2000), and Zuckerman & Webb (2000), using these sources, found evidences for two young associations near the South Pole, the Horologium (HorA) and the Tucana (TucA) Associations. To examine the possibility of these associations being the same and to search for other ones we undertook a Survey for Associations Containing Young-stars (SACY).

2. Results

We observed more than 400 stars in the surveyed area defined in de la Reza et al. in these proceedings. We obtained spectral classifications, radial velocities and equivalent width of Li I lines. The Li I line in late type stars can provide a first estimate for the age (Jeffries, 1995), selecting possible PTT. In SACY we consider that a star is probably younger than the Local Association if it is located near or above the limit proposed by Neuhäuser (1997).

In Figure 1a we plot the (U, V) space motions of the stars with Hipparcos parallaxes. There is a concentration of Li-rich stars near the position (-10, -20). Choosing the 10 stars near this position (visual binaries taken as mean values) we obtain as the mean space velocity components:

$$(U, V, W) = (-9.8 \pm 1.2, -21.7 \pm 1.1, -2.0 \pm 2.2) \text{ km/s}$$

The mean parallax of the stars is 20.2 ± 2.2 mas. We used the kinematical method, described in Torres et al. (2000), to estimate the distances and space velocities for the stars not measured by Hipparcos.

In Figure 1b we plot the space motions, deduced in this way, of the observed stars. There is a compact core of 44 Li strong stars, which are the “probable members” of a Great Austral Young Association (GAYA). In Figure 2a we show the histogram of the W velocities. It shows a double peak as if there are two similar associations. In Figure 2b and 2c we show the histograms of the distances of both groups. The group with greater W seems closer than the other. Is the GAYA actually split in two associations?

We made a global analysis with all stars having Li line similar to or stronger than the Pleiades, computing a grid of convergence points in velocity space. The above two groups stand out as the strongest concentrations. We tested also the convergence for the space velocities of the Chamaleon complex and obtained only a diffuse and little convincing concentration (as the possible stars are spread in all the observed area). Only four stars of the GAYA could also belong to the Chamaleon, but none is in its neighborhood.

In Figure 3 we show the celestial map of the observed stars. Those not in the concentration in the UV plane are evenly distributed, even the possible young ones. The proposed members of the GAYA are concentrated “near” the South Pole, between RA = 21H and 9H. The GAYA includes the HorA and the eastern part of TucA. It is so large that it is meaningless to call it for any constellation. The GAYA seems also to split in the sky, one of the groups

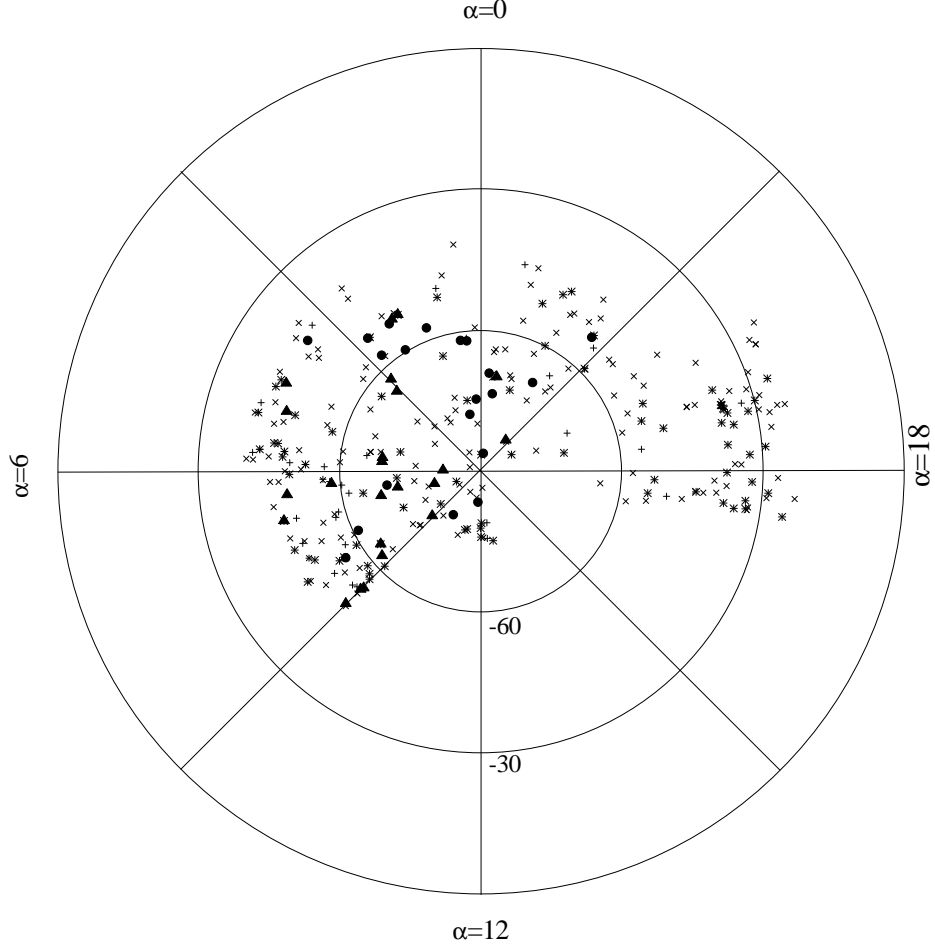


Figure 3. Celestial polar projection of the stars observed in SACY (giants excluded). Circles are the GAYA members with higher W (Fig 2b) and triangles with lower W (Fig 2c). Other symbols are for non-members: asterisks, plus and crosses for stars with Li lines stronger, similar or weaker (or absent) than the Pleiades, respectively.

being more concentrated to the east. But as its boundaries are not yet clearly established, and as in all diagrams and figures there is some superposition, we must wait for more observations to confirm this split. Anyway, there is no clear evolutionary distinction between the groups, both being very similar, having ~ 30 Myr.

The kinematical parallaxes give larger distances (~ 150 pc) for some stars but they are unreliable. Thus, the depth of the GAYA, from Figure 2, is ~ 70 pc, implying a projected angular diameter of $\sim 60^\circ$, similar to the observed size. If we suppose that the original velocity dispersion during star formation is equal to the average modulus of the velocity vectors (~ 1.5 km/s), the age of the GAYA would be ~ 20 Myr, similar to the evolutive age.

For most of the probable GAYA members we obtained at least three radial velocities with no indication of spectroscopic binaries. This possible low binary frequency is intriguing and in contrast with the TWA case.

The surveyed area has many other young stars and they should be investigated for other possible associations, even if the global analysis does not show any other prominent concentration. In fact, the high austral density of young stars seems to be real, being five times higher than the observed one in the region around BP Psc, where in 700 square degrees we found only four young stars.

3. Conclusions

Exploring a region covering about 30% of the Southern Hemisphere we found near the South Pole an association of at least 44 young stars (GAYA), younger (age ~ 30 Myr) than most groups of the Local Association and older than the TWA, ingulfing the HorA and part of the TucA. We did not yet detect spectroscopic binaries in the GAYA. The distances of the members of the GAYA cover an interval of ~ 70 pc, compatible with the size produced after 20 Myr by an initial velocity dispersion of ~ 1.5 km/s, in agreement with the evolutive age.

The GAYA is formed only by PTT, where none is an IRAS source, indicating the absence of dusty accretion disks. This suggests that, at their advanced evolutionary stage, the circumstellar disks have been dissipated or agglomerated into planetesimals. Thus, the members of the GAYA are privileged targets for studying the formation and early evolution of planets.

Acknowledgments. C. A. Torres thanks FAPEMIG, G. R. Quast CNPq and R. de la Reza CAPES for providing financial support. This work was partially supported by a CNPq grant to L. da Silva (pr. 200580/97) and to C. Melo (proc. 200614/96-7). We thank M. Sterzik and B. Reipurth for instructive discussions and M. Mayor for the use of the Swiss telescope.

References

- de la Reza, R., Torres, C. A. O., Quast, G., Castilho, B. V., & Vieira, G. L. 1989, *ApJ*, 343, L61
- Gregorio-Hetem, J., Lépine, J. R. D., Quast, G. R., Torres, C. A. O., & de la Reza, R. 1992, *AJ*, 103, 549
- Jeffries, R. D. 1995, *MNRAS*, 273, 559
- Neuhäuser, R. 1997, *Science*, 276, 1363
- Torres, C. A. O. 1998, *Publicação Especial do Observatório Nacional*, 10/99
- Torres, C. A. O., da Silva, L., Quast, G., de la Reza, R., & Jilinski, E. 2000, *AJ*, 120, 1410
- Torres, C. A. O., Quast, G., de la Reza, R., Gregorio-Hetem, J., & Lépine, J. R. D. 1995, *AJ*, 109, 2146
- Zuckerman, B., & Webb, R. A. 2000, *ApJ*, 535, 959